U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE MICROSCOPIST

FOR

1892.

BY

THOMAS TAYLOR, M. D.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1892.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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REPORT OF THE MICROSCOPIST.

SIR: I have the honor to submit herewith my twenty-first annual report, covering the work of the Division of Microscopy for the year 1892.

THOMAS TAYLOR,
Microscopist.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

During the past year this division has been largely engaged in collecting specimens of the edible and poisonous mushrooms of the United States and Territories, intended for exhibition, collectively, at the World's Columbian Exposition. In this work the division has had the cordial assistance of the agricultural experiment stations of the country, and upward of six hundred molds have been made of the perishable forms, in addition to which several thousand specimens of the woody fungi have been collected for the exhibition. Models of the perishable species will be colored from nature and grouped and classed according to their edible or poisonous character. The groups as a whole will illustrate, in miniature, a forest scene and, indirectly, will show some of the permanent causes of forest decay.

In consequence of the increased demand by the public for information relating to the cultivation of edible mushrooms, this subject has received further attention, and new illustrations will be published from time to time showing the latest successful methods in this direction. Mushrooms have been received in great numbers from all parts of the United States, the result of an increased interest in them as an article of food. Many of our correspondents have commenced the cultivation of this esculent as a source of profit, a number of whom have succeeded.

Public attention is again directed to the trade in spurious butter, which seems to have been revived in this city. Quite recently a number of samples of oleomargarine, butter-like in appearance, which have been sold as butter without the brand required by the law, have been submitted to me for investigation and determination.

As the force of this division is at present restricted to two assistants, and much additional work has been undertaken by it relating to the Columbian Exposition, I have been unable to report progress in relation to the measurement and strength of textile fibers, but many valuable samples of the cotton product of the world have been received from Liverpool, Egypt, and the various cotton exchanges of the United States; that from Liverpool being selected with great care, especially for this division, and presented by Mr. Peter Brown, secretary of the Liverpool Cotton Association, embracing admirable specimens of the

cottons of Europe, Asia, and Africa. The samples of Egyptian cotton were presented to the division by Mr. J. T. Callender, of New Orleans, La., and those from Liverpool, England, through the New Orleans (La.) Cotton Exchange. For valuable and well-selected samples of our own cotton staple we are indebted to Messrs. H. G. Hester and J. W. Barkdull, of the New Orleans (La.) Cotton Exchange; J. P. Merrihew, Savannah (Ga.) Cotton Exchange; R. H. Bolling, of the Mobile (Ala.) Cotton Exchange; A. G. Mills, Galveston (Tex.) Cotton Exchange; and R. A. Tavel, of the Charleston (S. C.) Cotton Exchange. Valuable flax samples of the four principal varieties which form the staple of commerce are included in the collection belonging to this division; also, samples of European and Asiatic ramie and of our domestic product. Samples of the fiber used in the manufacture of farmers' binding twine and shipping cordage constitute a part of the collection and await but the time and opportunity to carry on the work outlined in this direction and for the prosecution of which preparations have been made. A large assortment of animal fibers is also embraced in this collection for investigation and comparison.

Over seven hundred letters have been received during the past year, and upwards of four hundred written and copied; the disproportion between letters received and answered being the result of lack of clerical force and time to do more in many cases than to mail the divisional reports in reply to correspondents.

EDIBLE AND POISONOUS MUSHROOMS.

In my earlier papers upon the edible and poisonous mushrooms of the United States, it was my purpose to give simply a general and popular statement regarding some varieties desirable for food purposes. It was also my aim to point out how to detect poisonous species without special regard to scientific nomenclature. While it is not my intention to abandon this plan of instruction, it seems now necessary, owing to the deep and widespread interest manifested in my reports on the mushrooms, to enter more into scientific detail based upon microscopic observation of the spores and varied structure of these plants. I have therefore given in my present report more of the scientific nomenclature than heretofore, as to diversity of structure, form, and color of the tissues, necessary to be understood in a study of these plants as a means of discriminating between them.

In my present report, my first two illustrations represent two species of the genus *Amanita*, the first, called popularly "the orange," an edible mushroom; the second, "the false orange," a poisonous species. Some of the most beautiful species of this genus have been mistaken for the edible species, and for this reason all the nutritious esculents of this class have been considered doubtful, especially in America, and bushels—not to say tons—of valuable nitrogenous food are annually wasted that would otherwise, under proper cultivation, yield a fruitful food supply and source of revenue. Following the *Amanitas*, I have selected a species of *Lepiota*, abundant in the United States, and which forms in Italy, especially, a favorite article of food. The *Lepiotas* are all edible. My last plate of this series represents a species of *Cortinarius*, drawn and colored from the natural plant and found abundantly under mounds of pine needles in the autumnal months, in Prince George County, Md. I have fully tested this mushroom and find it very good eating.

CULINARY PREPARATION OF CERTAIN EDIBLE MUSHROOMS.

The following methods of preparing the foregoing edible mushrooms for the table will be found useful:

"The Orange."—Remove peel and stems, but reserve the upper half of the stems. Rinse the mushrooms well in cold water, take them out and wipe them dry in a soft cloth. Make force meat with the upper part of the stems minced, bread crumbs, sweet herbs, garlic, pepper, salt, and a little oil. Pack this upon the gills of the mushrooms. Put them on a plate in a hot oven and continue to baste them with oil. Give them fifteen minutes and serve. They are much improved by roasting before a hot fire in a Dutch oven.

Lepiota procera.—Remove the stem and peel. Rinse the mushrooms well in cold water, take them out and wipe them carefully with a soft cloth. Then put them into a well-buttered pie dish with a little butter on them, or cream, and with toasted bread below. Sprinkle with pepper, salt, and parsley that has been rubbed with garlic and minced. Cover with oiled paper and a plate. Bake in a hot oven fifteen minutes. Serve in dish without removing the cover. The *Lepiota procera* also yields a first-rate catsup.

Cortinarius turmalis.—Take large ones. Remove the stems but not the peel nor gills. Rinse in cold water, then scald them by throwing the mushrooms into a pan of boiling water. Do not let them remain in the hot water more than a few seconds, but take them out immediately and wipe them carefully dry in a soft cloth. Then powder them slightly with flour. Put a little butter, pepper, and salt on the gills. Lay them top downwards on a gridiron over a moderate fire for five or six minutes at the most.

DETECTION OF POISONOUS MUSHROOMS BY MEANS OF A SILVER SPOON, ONIONS, ETC.

Considering that an opinion seems to prevail that the discoloration of the silver spoon or small white onions when brought into contact with mushrooms during the culinary process is an infallible test of the poisonous species, I quote from a French author on mushrooms the following in relation to this supposed test and some other popular fallacies regarding the detection of edible and non-edible species:

* * * We may not dispute the fact that a silver spoon or article of brass, or onions, may not become discolored on contact with the poisonous principle, but this discoloration is not reliable as a test for deciding the good or bad quality of mushrooms. In fact, we know that in the decomposition of albuminoids sulphureted hydrogen is liberated which of itself discolors silver, brass, and onions.

I have deemed it advisable to publish this as one of the best means of answering those correspondents who have made inquiries as to the reliability of this test.

Mushrooms that change color when cut are not always poisonous; on the contrary, we know that several of the non-edible *Amanitas* do not change color when they are cut.

Mushrooms of vivid colors and viscid caps are not always poisonous. It is by some supposed that high colors and viscidity are indications of non-edible species, but there are numerous exceptions here. *Russula alutacea*—the pileus of which is often a purplish red—*Amanita Cæsarea*, and other species of brilliant coloring are known to be edible. As to viscidity, two very viscid species, when young, are among the highly prized esculents by those who know them, viz, *Fistulina hepatica*, or the ox tongue, and *Hygrophorus eburneus*, the ivory mushroom.

The method of deciding the character of mushrooms by their odor and flavor is not to be relied upon. Edible mushrooms are usually characterized by an odor like that of fresh meal, and a flavor of hazelnuts; non-edible varieties have sometimes an unpleasant odor, and produce a biting, burning sensation on the tongue and throat, even in very small quantities, but several of the *Amanitas* have only a slight odor and taste, and certain species of mushrooms, acrid otherwise, become edible when cooked.

EXPLANATION OF PLATES.

PLATE I.—AMANITA CÆSAREA Scopoli ("The Orange").

(Edible.)

[Leucosporæ—White spores.]

Cap hemispherical as in Fig. 1, then expanded, smooth, free from warts, bright red or orange, shaded lemon yellow toward the margin, which is widely and distinctly striate. (See Fig. 2.) Stem equal or slightly tapering upwards, stuffed with cottony fibrils, or hollow; color a clean light yellow, bearing a yellowish ring near the top, and encased at the base in a large, loose, membranous, white volva. Gills free, color light lemon yellow. Spores white, and elliptical. (Fig. 4.) The plant is usually from 5 to 8 inches in height. Breadth of cap when extended, from 4 to 8 inches. Figs. 3, 3*a*, and 3*b* are sectional views of the plant. *A*, view of the embryonic stage of the plant.

PLATE II.—AMANITA MUSCARIA Linnæus ("False Orange").

(Poisonous.)

[Leucosporæ—White spores.]

Cap is at first ovate as in Fig. 1, then broadly convex or nearly plane as in Fig. 2. When young and moist, slightly viscid, rough, with numerous whitish or yellowish warts, rarely smooth, narrowly and slightly striate on the margin, ochraceous yellow or orange-red color. Gills white, as in Fig. 3, stem equal or slightly tapering upwards, stuffed with webby fibrils, as in sectional view 4, or hollow, bearing a white deflexed ring, ovate-bulbous at the base, white or yellowish. The volva usually breaks up into scales, which adhere to the upper part of the bulb. Spores white, elliptical (Fig. 5), from .0003 to .0004 inch long by .00025 to .0003 inch broad. The plant is found from June to October, growing from 5 to 8 inches high; cap from 3 to 6 inches broad.

PLATE III.—LEPIOTA PROCERA Scopoli ("The Parasol").

(Edible.)

[Leucosporæ—White spores.]

Cap fleshy, at first ovate, then expanded and umbonate; cuticle thick, torn up into scales; stem tall, at first stuffed, then hollow, bulbous, with closely pressed scales; ring movable, gills very remote. Fig. 1 represents a young form; Fig. 2, a more advanced growth; Fig. 3, full-grown plant; Fig. 4, top view of cap; Fig. 5, sectional view of the cap and stem; 5*a*, 5*b*, 5*c*, represent cross sections of the stem; Fig. 6, the spores. This mushroom is abundant in the United States, agreeable in odor and flavor. Its flesh does not change. Gills at first white; change finally to flesh color, bordered with brown. Breadth of cap from 5 to 8 inches; length of stem from 8 to 12 inches. The original from which this fine specimen was drawn was found growing in pine woods in Prince George County, Md.

PLATE IV.—CORTINARIUS TURMALIS Fries.

(Edible.)

[Ochrosporæ—Ochraceous spores.]

Cap fleshy, convexo-plane (Fig. 1); viscid in wet weather; from 2 to 4 inches broad; ochraceous yellow, shining. Flesh soft. Veil or cortina extending from the margin of the cap to the stem in delicate araehnoid threads, best seen generally in the young plant. The stem is cylindrical, white, 3 to 4 inches in length, rather attenuated than thickened, as in Figs. 1 and 2, but in some cases I have observed a thickening at the base. The remnants of the cortina or veil appear above the middle of the stem as a zone of minute striæ, darker than the stem. (Figs. 1 and 2.) The gills are ochraceous yellow when mature, close, emarginate (see sectional view, Fig. 3), and decurrent, depending on the age of the plant. By some authors the gills are described as, at first, white. Spores fusiform, as in Fig. 4, color brownish-ochraceous yellow. Fig. 5 represents a section of the pine-needle mounds formed by this species, as they generally appear in pine woods.

AMANITA CÆSAREA, SCOPOLI.

A. Embryonic form 1. Young plant. 2. Mature plant

3. 3a and 3b. Sectional views. 4. Spores.

AMANITA MUSCARIA, LINNÆUS.

A Embryonic form. 1. Young plant.
2. Mature plant. 3. Under view of cap. 4. Sectional view.
5. Spores.

Friedmann Bailey & Blampey, N. Y.

LEPIOTA PROCERA SCOPOLI.

1. Young plant. 2. Cap expanding, umbonate.
3. Mature plant. 4. Top view of cap. 5. Sectional view.
5a, 5b, 5c Cross sections of stem. 6. Spores.

Trautmann, Bailey & Blampey N.Y.

CORTINARIUS TURMALIS, FRIES.

1. Mature plant, 2. Under view.
3. Sectional view. 4. Spores.
5. Manner of growth.

THREE EDIBLE MUSHROOMS.

AMANITA *Persoon.*

The genus *Amanita* holds the first place in the order *Agaricini*, and may be regarded as representing the most perfect type of the Hymenomycetes, consisting of mushrooms which have reached the highest stage of development. The mushrooms of this class are furnished in youth with a volva and ring. *Amanitas* have a cap that is usually plano-convex, the flesh thick in the center and growing thin toward the margin. The gills are ventricose, narrowing at the extremities, free, and numerous; half gills are rare. The stem is central, frequently swollen or bulbous at the base, solid, or stuffed interiorly with cottony fibrils more or less evanescent. The ring is persistent, deflexed, more or less prominent, in rare cases close against the stem, and sometimes scarcely distinguishable from it. Flesh and gills are white. There is an edible species, however, which has gills of a clear golden yellow.

The *Amanitas* are not a numerous family, and most of them are regarded as dangerous, but the *Cæsarea* (Plate I), which I have placed first in my present list, may be regarded as first of all mushrooms for food at the present time. This large, beautiful, and very showy plant, found from August to October in wet seasons in thin, open woods in Europe and North America, is not found in England* and is not very common. The American plant seems to differ from the European species in some slight respects, as represented in figures and descriptions. In Europe the pileus or cap is said to vary in color, being sometimes white, pale yellow, red, or even copper color, although it is usually orange yellow. In our own plant, according to Prof. Peck, of New York, the cap is uniform in color, being at first bright orange, or even brilliant red, fading with age to yellow, either wholly or only on the margin. The red color entirely disappears in the dried specimens. The striations of the margin are quite deep and long, and almost as distant as in *A. vaginata*, where they are said to be "pectinate-sulcate." In Europe the flesh is represented as yellowish. In our plant the flesh is white, yellow, or red under the cuticle, but next the gills—that is to say, the under surface of the cap to which the gills are attached—the flesh is generally yellow. The stem is described as subventricose in our plant. Says Prof. Peck:

> I have always found it equal or slightly tapering upwards, and generally rather long in proportion to the size of the pilens, so that the American plant must have a more graceful aspect than the European. The color of the stem is yellowish; the ring is sometimes tinged with this hue. The volva is soft and almost tomentose in texture, yet distinctly membranous, persistent, and white. The lamellæ are of a light citron-yellow color, by which it is at once distinguished from all our other species of *Amanita*. All authors agree in attributing esculent qualities to this mushroom.

In conclusion, I deem it safe to say that any mushroom having a white volva and gills of a citron-yellow color is *Amanita cæsarea*.

We are assured by some authorities that the Russians are accustomed to eat the *Amanita* indiscriminately without experiencing the least unpleasant effects. Mérat relates having seen the bodyguard eat plenti-

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* Curtis says that it grows in great quantities in oak forests in the United States, and may be found by the cart-load in its season.

fully of them without ill effects. (D'Orbigny's Dict. Natural History, Vol. I, p. 177.)

An instance of eating the embryonic form of the *Amanita* without harmful results was related to us by a correspondent in Florida, who supposed he had discovered a region of truffles and was accustomed to eat freely of the egg-shaped *Amanita*, not discovering his mistake until a specimen was sent here for identification as a supposed truffle. I was unable to discover from the samples sent to what species of *Amanita* the plant belonged.

Another instance in this country is related also by one of our correspondents in Oregon, an extract from whose letter is here given:

> With this mail I send you what I shall call the poultry mushroom till you give me a better name for it. In its habits it seems a link between vegetable and animal life. It lives in fir and hazel woods, on hill or flat ground. At first it pushes itself up through the ground and sits up on end just like an egg, from size of a grouse's egg to that of a giant goose-egg. The period of the hatch depends upon the degree of humidity and heat in the atmosphere. Generally it requires about three days. One other quality it has in common with its biped relative: it sometimes dies and rots in the egg. My son first drew my attention to it about three years since. He found it on the mountain when bringing the cattle home. I then knew the meadow mushroon and the morel as edible fungi, but this looked so pure and sweet I cooked it and fed it to the dog and cat and the hens. Then I cautiously partook myself and found them fine. My method of cooking them is to peel and slice them and wash them in cold water, put them to stew in melted butter, pepper, and salt for a quarter of an hour; then thicken with flour and bread crumbs and serve with or without toast. They do not easily decay. I send you three of the egg form and one full-grown specimen.*

Lepiota *Fries.*

This genus is distinguished by a well-developed annulus, which soon breaks loose from its attachment to the stem and forms a movable ring upon it. The substance of the cap known as the hymenophorum is distinct from the stem, the latter reaching up into a distinct cavity or depression in the pileus, which forms the umbonated feature of the cap as illustrated in Plate III. The species of this subgenus are generally smaller than those of the preceding (*Amanita*) and most of them have the pileus rough, with tufts or scales formed by the breaking up of the cuticle. According to Prof. Peck the only representative of this subgenus in the State of New York a few years ago was the species *procerus*, but several other species, as *rachodes*, *excoriatus*, *mastoideus*, and *Morganii*, were reported from neighboring States. All the European species of this subgenus are classed by Fries as edible.

It is recommended, in preparing this mushroom for food, to gather the plant just before the veil breaks away from beneath the gills; remove the veil, but do not wash the plant. Simmered in a stew pan for half an hour, it will form its own gravy. The flavor closely resembles that of meat. *Lepiota procera* requires slow cooking to prevent toughness.

Cortinarius *Fries.*

The distinguishing features of the genus *Cortinarius*, to which the species *turmalis* (Plate IV) belongs, are: (1) Gills not changing to a dark brown or black as in the *Pratellas*, but assuming a cinnamon color with age, probably from the deposit of spores; (2) a cortina or veil which is an imperfect membrane, or rather web, composed of filaments or threads

*The specimen was not a full-grown *Amanita*, but a full-grown embryo of an *Amanita*, the egg form.—T. T.

interlaced loosely, resembling the delicate web of the spider. It varies in hue, is in some species persistent, in others evanescent, leaving either upon the margin of the cap or on the stem, or both, its filamentous remnants, located, as regards the stem, above, below, or midway, as hereafter described, and represented by a mere zone of darker colored fibrils (illustrated in Plate IV), sometimes scarcely perceptible. I observe that some of the French authors do not class this species as edible. Gillet in his Hymenomycetes of France enumerates fifty-three edible species of *Cortinarius*, but places *turmalis* among the suspects. Dr. Gautier describes ten edible species of this genus, but we do not find *turmalis* among them. I find this mushroom edible and of great value. It is very plentiful in the pine woods of Maryland. I have collected a bushel of them in less than an hour in fresh condition, in the early part of October. These plants are easily discovered by those familiar with their habitat, as they grow under the pine needles in groups, forming small mounds extending over great spaces, and in these hiding places, in the autumnal months, they are free from insects and dust. (See Plate IV, Fig. 5.)

THE VOLVA.

The volva is a membrane which envelops the entire plant in embryo, giving it the appearance of an egg. Its texture is so delicate that it generally disappears without leaving the least trace of its previous existence on the adult plant. Otherwise, traces of the volva are left upon the upper surface of the cap more or less prominent, numerous, and thick, sometimes regularly disposed, sometimes irregularly, in the form of plates, warts, etc. At the base of the stem of the mushroom the remains of the volva are seen in the form of a sort of wrapper, more or less ample, thick, and ascending, in other cases as a mere border, distant more or less, or as merely a few scales. As will be seen by reference to Plate I the plant emerges from the volva (Figs. 1 and 2). The volva is a feature of great importance in the study of the Agaricini, of the genera *Amanita* and *Volvaria*.

THE MUSHROOM VEIL.

The veil is not a constant feature in the Agaricini, at least it is not always visible. When present it consists of a membrane which extends from the margin of the cap to the stem, veiling or protecting the gills. This membrane, called the cortina, has given its name to a numerous and important class of mushrooms (the *Cortinarias*). It is generally white, soft, slightly spongy, cottony, at times fibrillose or even slightly fibrous, again in texture comparable to the spider's web, and may be even powdery or glutinous. It exists intact only in the youth of the plant. It is not visible in the developing mushroom, at least while the cap is closely pressed against the stem, but as the cap expands the membrane extends and finally breaks, leaving in some species its remnants upon the margin of cap and upon the stem in the usual form of a ring or a mere zone, as described and illustrated in Plate V.

Explanation of Plate V.

Plate V illustrates, by section or otherwise, various forms and positions of the annulus or ring characteristic of certain species of mushrooms, together with the cortina or veil, of which the ring, if present, is the remnant, in some species, either as it

appears entire or as a fringe on the margin of the cap, contrasting these forms with a sectional view of a species in which the veil or ring are always wanting.

Fig. 1. Ring broad, reflexed or deflexed, or both; situated high up on the stem, as in *Armillaria mellea;* edible.

Fig. 2. Ring situated about midway of the stem, deflexed and pendulous.

Fig. 3. Ring about half midway of the stem, split, and radiating outwards, as in *Agaricus arvensis;* edible.

Fig. 4. Ring low upon the stem, near its base.

Fig. 5. Ring persistent, movable, wholly detached, in age, from the tall and slender stem, upon which it easily slips up and down. A species of great beauty, *Lepiota procera;* edible.

Fig. 6. Ring narrow, scarcely perceptible above the middle of the stem; remnants of the veil adhering to the margin of the cap as a fugacious web.

Fig. 7. Ring generally wanting—*Tricholoma nudum;* edible; remnants of the veil seen on the margin of the cap.

Fig. 8. Remnants of the veil appearing on the margin of the cap as a fringe, and particularly on the stem as a mere fibrillose zone of a darker color.

Fig. 9. Plant exhibiting the cortina unbroken, the extremities of its delicate arachnoid threads attached to cap and stem, respectively.

Fig. 10. Section of a Russula in which subgenus the ring is always wanting; veil none.

MUSHROOM GILLS.

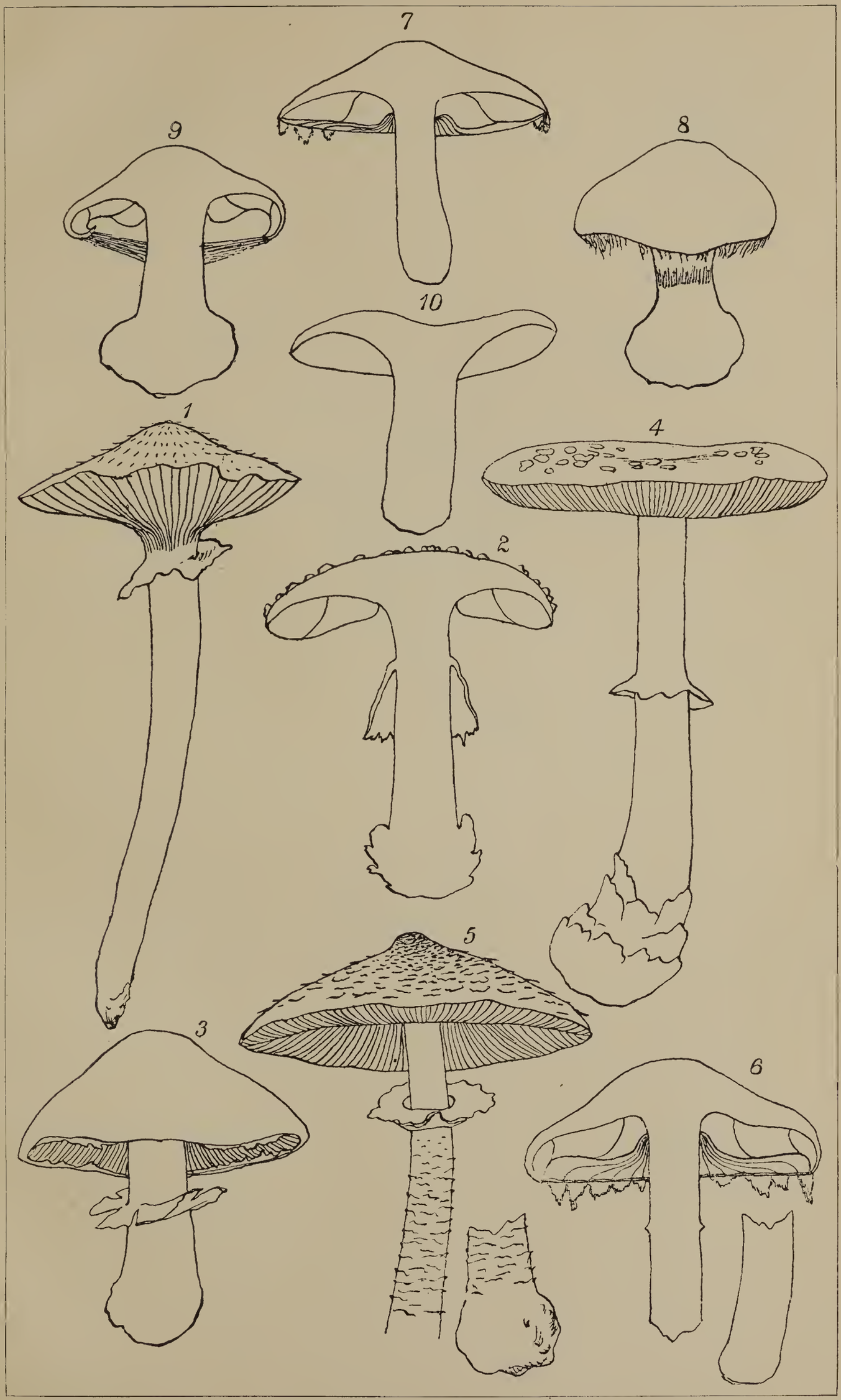
The gills of the mushroom are vertical, simple, equal, respectively, or more frequently alternating with shorter gills and entirely covered, as well as the intervening spaces by the sporiferous membrane, the hymenium. They are very often evanescent and putrescent, sometimes liquefying altogether. Their color is usually different from the upper surface of the cap, not always similar to that of the spores borne upon them, at least in youth; with age, however, they usually assume the color of the mature spore. The change of color of the gills according to the age of the plant is very important in the study of the Agaricini; it accounts for the white gills of certain species in youth, the pink in maturity, and the brown when aged. The gills, anatomically considered, are composed, first, of a central portion, a prolongation of the tissue of the hymenophore or flesh of the cap, more or less dense, scarcely perceptible sometimes; second, the hymenium covering the two surfaces of this prolonged hymenophore.

The end of the gill nearest the stalk of the plant is termed the posterior extremity; the opposite end, the anterior extremity. In most of the Agaricini the gills are unequal. Some extend from the margin to about half the space between it and the stem; others are still shorter. In Russula the gills are perfect or entire, that is to say, reach from the margin to the stem. The species *furcata*, however, is an exception, having a few forked gills.

Explanation of Plate VI.

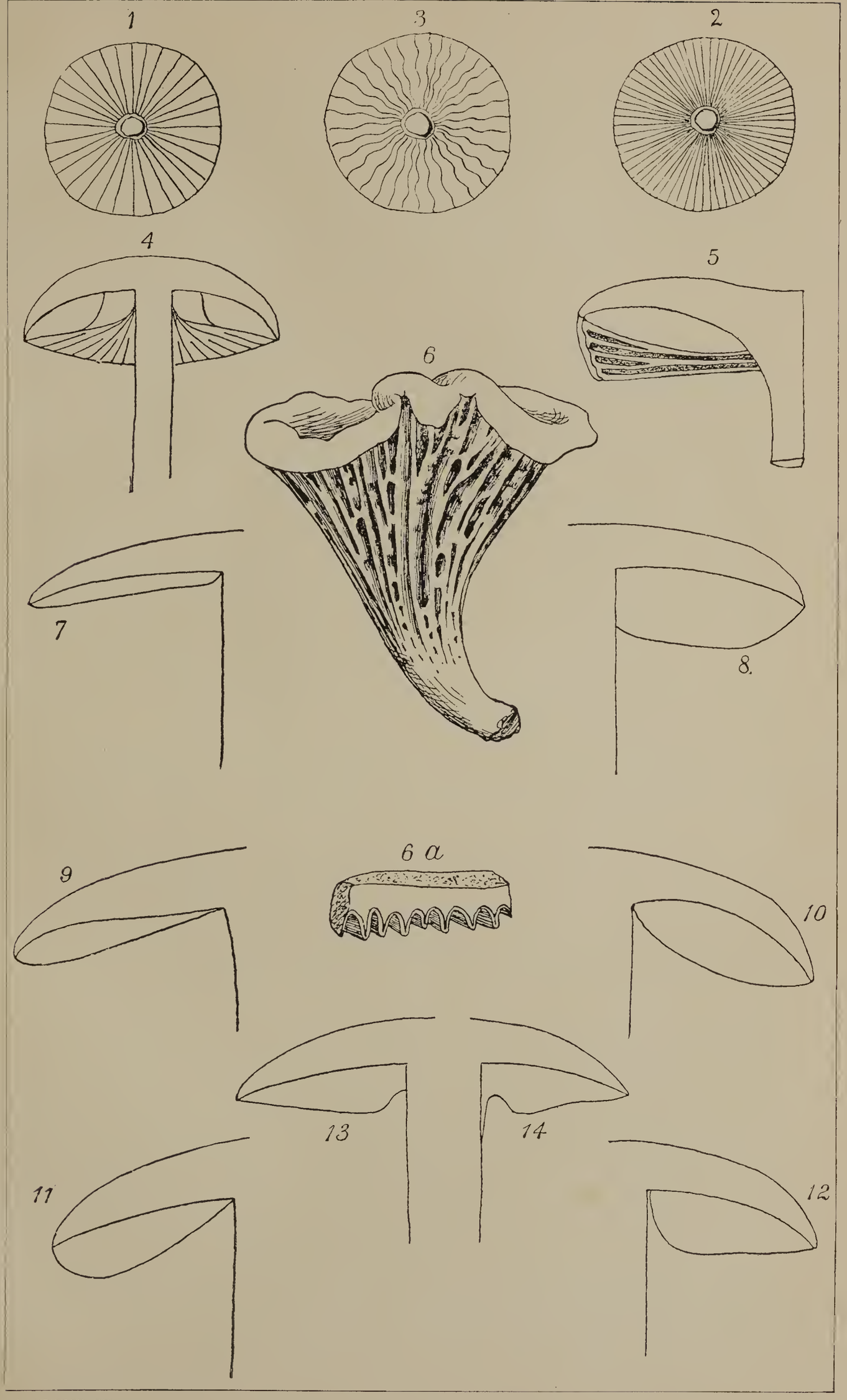
Plate VI illustrates by section or otherwise (being a continuation of my figures in Plate VI of my former report, 1891), various forms of these gill-like processes characteristic of species, considered either with regard to marginal outline or position of their posterior extremity:

Fig. 1. Gills distant.
Fig. 2. Gills crowded.
Fig. 3. Gills flexuose.
Fig. 4. Gills unequal.
Fig. 5. Bifurcated.
Fig. 6. Anastomosing veins.
Fig. 6*a*. Sectional view.
Fig. 7. Gills narrow.
Fig. 8. Gills broad.
Fig. 9. Lanceolate.
Fig. 10. Ventricose.
Fig. 11. Anteriorly rounded.
Fig. 12. Posteriorly rounded.
Fig. 13. Emarginate.
Fig. 14. Emarginate and denticulate.



L. KRIEGER, DEL.

FORMS AND POSITION OF THE ANNULUS OR RING.



L. KRIEGER, DEL.

FORMS OF GILL-LIKE PROCESSES.

MUSHROOM SPORES.

Mushroom spores are very variable in size, shape, and color, but tolerably constant at maturity in the same species and even in different species of the same genus. This feature, varying thus with the age of the plant, should be studied in the mature plant. The size of spores varies from one-hundredth to a few thousandths of a millimeter in diameter. Their shape, almost always spherical in the young plant, becomes ovate, ellipsoidal, fusiform, reniform, smooth, stellate, sometimes tuberculate, or remains globose. The spore colors of the Agaricini are defined as follows by various authors:

According to—

Elias Fries, 5 groups: *Leucosporus,* white; *Hyporhodius,* pink; *Cortinaria,* ochraceous; *Derminus,* rust; *Pratella,* purplish black.

Rev. M. J. Berkeley, 5 groups: Very frequently pure white, but presenting also pink, various tints of brown, from yellowish and rufous to dark bister, purple-black, and finally black; *Leucospori,* white; *Hyporhodii,* salmon; *Dermini,* ferruginous; *Pratellæ,* brown; *Coprinarius,* black.

Dr. Badham, 6 groups: Pure white or a yellow tinge on drying; brown; yellow; pink; purple; purple-black; some pass successively from pink to purple and from purple to purple-black.

Mrs. Hussey, 11 shades: White; rose; pale ocher; olivaceous-ocher; reddish-ocher; ochraceous; yellowish olive-green; dull brown; scarcely ferruginous; snuff-color; very dark brown.

Hogg & Johnson, 5 groups: *Leucosporei,* white; *Hyporhodii,* salmon; *Dermini,* rusty; *Pratellæ,* purplish-brown; *Coprinarius,* black.

C. Gillet, 7 shades: White; pink; ochraceous; yellow; ferruginous; black or purplish-black; round, ovate, elongated, or fusiform, smooth, tuberculate or irregular, simple or composite, transparent or nebulous, etc.

Jules Bel, 5 groups: White; pink; red; brown; black.

Dr. Gautier, 5 shades: White; pink; brown; purplish-brown; black.

Constantin & Dufour, 5 groups: White; pink; ochraceous; brownish-purple; black.

J. P. Barla, 7 groups: *Leucosporii,* white; *Hyporhodii,* pink; *Cortinariæ,* ochraceous; *Dermini,* rust; *Pratellæ,* purplish-black; *Coprinarii,* blackish; *Coprini* and *Gomphi,* dense black.

L. Boyer, 5 groups, 11 shades: White to cream yellow; pale pink to ochraceous yellow; bay or red brown to brown or blackish bister; rust color, cinnamon or light yellow.

W. D. Hay, 5 groups: White; pink; brown; purple; black.

C. H. Peck, 5 groups: *Leucosporii,* white; *Hyporhodii,* salmon; *Dermini,* rust; *Pratellæ,* brown; *Coprinarii,* black.

Saccardo, 6 groups: *Leucosporæ,* white; *Rhodosporæ,* pink; *Hyporhodiæ,* salmon; *Ochrosporæ,* yellow; *Derminæ,* brown; *Melanosporæ,* black.

Dr. M. C. Cooke, 5 groups: *Leucospori,* white or very slightly tinted; *Hyporhodii,* rosy or salmon color; *Dermini,* brown, sometimes reddish or yellowish brown; *Pratellæ,* purple, sometimes brownish purple, dark purple, or dark brown; *Coprinarii,* black or nearly so.

These shades are somewhat different from the colors of the mushrooms' gills, so that, when it is of importance to determine exactly the color of the spore in the identification of a species, we may without recourse to the microscope cut off the stem of an adult plant on a level with the gills and place the under surface of the cap upon a leaf of white paper if a dark-spored species and upon a sheet of black paper if the spores are light. At the expiration of a few hours we will find, on lifting the cap, a bed of the shed spores which will represent their exact shade. These may be removed to a glass slide and their size determined by means of the microscope.

From my own observations of spore colors under the microscope, I consider that the diversity of colors as above quoted would probably have been less had the respective authors been professional artists or even familiar with the well-known names and chemical properties of

art water colors, such as those of Windsor and Newton, which have been well known by every artist for the last sixty years, the shades of colors being always the same. The terms white and black are understood by all English-speaking people, but the term pink is indefinite, since there are many shades of pink all known by different names, because made from various plants, and each color thus named has a constant sameness of consistency and composition. The terms bister, brown pink, vermilion, cobalt blue, Prussian blue, cadmium yellow, are well known constant colors, but some of the authors above quoted speak, for example, of yellowish spores, ochraceous, snuff color and ash color. In describing yellow it is very important to state the tone or tint. We have lemon yellow, yellow ocher, three shades of chrome yellow, King's yellow, Naples yellow, gamboge, etc., colors well known to be constant in tint. Rust of iron yields two well-known colors, the yellow a protoxide of iron and the red a peroxide of iron. These rusts are frequently combined with clay and thus constitute pigments, the one yellow ocher, the other red ocher. I am glad to see, in a recent pocket manual by Messrs. Costantin & Dufour, published in the French language, that a diagram lettered and numbered is appended representing the natural colors of the respective species of mushrooms, not alone spore colors, the letters and numbers of the diagram referring to corresponding figures upon each plate of illustrations, thus assisting the student to obtain a correct idea of the usual colors of the living plant.

AUTHORITIES CONSULTED.

Fries.
Saccardo.
Paulet & Léveillé.
Gillet.
Boyer.
Bel.
Gautier.
Badham.
Hussey.
Hogg & Johnston.
Berkeley.
Peck.
Curtis.
Falconer.
Hay.
Robinson.
Palmer.
Costantin & Dufour.
Cooke & Berkeley.
Cooke, M. C.
Stevenson.
Schaeffer.
Barla.
Léveillé.
Worthington G. Smith.

SILVER NITRATE TEST FOR OILS.

It has been customary for several years past to use a solution of silver nitrate as a means of detecting cotton-seed oil as an adulterant of food oils and fats. In some recent experiments with the silver nitrate solution combined with an oil and subjected to a boiling temperature, I observed that opposite every point where a vapor explosion occurred a whitish deposit appeared upon the inner wall of the test-tube. When the tube containing the mixture had been exposed for several days to the indirect rays of the sun, I observed that the white deposits no longer appeared an opaque white, but as bright sparkling spots of pure silver. From several experiments of this sort I was led to suppose that an aqueous solution of the silver nitrate of the usual strength used in such experiments would yield similar results in the absence of any fatty substance. Later experiments demonstrated this to be the case. It therefore seemed somewhat dangerous to rely wholly upon hot solutions of silver nitrate as a means of determining the presence of cotton-seed oil in food compounds. Still later experiments clearly show that several oils other than cotton-seed oil not only deposit silver in various colors, but in larger amounts than is produced by cotton-seed oil; but to make

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this more clear I made other experiments, using the same combination of silver and oils, but without the application of heat, with very satisfactory results, its full value only restricted by the greater length of time required to obtain such results.

Explanation of Plate VII.

Plate VII represents eight test-tubes, each containing a solution of the silver nitrate and an oil. (The silver solution used in all these experiments was of uniform strength, prepared by diluting a saturated solution of silver nitrate one-fourth, with distilled water.) *A*, lard oil and the silver solution; *B*, cotton-seed oil and the silver solution; *C*, poppy-seed oil and the silver solution; *D*, linseed oil and the silver solution; *E*, peanut oil and the silver solution; *F*, colza oil and the silver solution; *G*, olive oil and the silver solution; *H*, castor oil and the silver solution.

The proportions of the silver solution and oil were the same in each case.

My usual method is to fill each test-tube one-third full of the silver nitrate solution and fill the remaining two-thirds of each tube with the respective oils to be tested. The tubes are then closed tightly with a stopper and each tube is well shaken and then placed in a rack exposed to indirect sunlight. The immediate results are observed, as well as the daily changes, and both are noted. The first precipitation of silver may be white or dark without the silver brilliancy.* Colors of various shades begin to appear in the condition of allotropic silver. After standing several months in a shady place the deposits of silver as well as the changes of color are greatly increased, and show several well-marked and typical conditions.

Pure lard oil *A* exhibits a large amount of the precipitate, of a silvery appearance more or less.

Cotton-seed oil *B* exhibits at the bottom of the tube the appearance of a solid deposit of burnished gold, which two months later appeared a copper color.

The precipitation of silver in tube *C* is not uniform, although considerable in amount.

Tube *D* presents a remarkable condition, exhibiting a branching deposit of silver in the upper part of the tube, and this is characteristic of linseed oil.

Tubes *E*, peanut oil, and *F*, colza oil, exhibit slightly varied forms of silver precipitate.

Tube *G*, olive oil, and *H*, castor oil, exhibit much less of the silver precipitate. It will be seen at a glance that olive oil has precipitated a smaller amount of silver than any of the other oils represented, thus demonstrating that olive oil has less affinity for oxygen than either of the other oils named. For this reason, crude olive oil has been used as a lubricant for machinery.

It will also appear self-evident, from the foregoing, that oils which precipitate large quantities of silver can not be used as lubricating oils, since they will corrode iron. On the other hand, the results of these silver tests demonstrate that if olive oil is adulterated with either of the oils, especially the first named, the presence of the adulterating oils would be easily detected, because of the comparatively large amount of silver which would be precipitated, particularly in the use of the cold silver test. In my former reports I have pointed out that fresh, pure lard has little or no reaction upon the silver nitrate, while a lard containing free oleic acid, the result of exposure, would precipitate the silver. I have experimented with chemically pure oleic acid and the silver solution, using heat, and I find that by it silver is readily precipitated, and for the same reason any rancid oil may give the same results. It is therefore necessary to test first for the presence of acids. We should also test for the presence of alkalis, as they cause a precipitate of oxide of silver, and would thus frustrate the experiment.

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*The color of metals thus precipitated depends upon the size of their grains. If very fine, the color is dark, if coarse, the true color of the metal is shown, because the coarse grains reflect more light.

CRYSTALLIZATION OF OILS OR THEIR ACIDS.

The freezing-box (Plate VIII) is a new device which I have prepared for use with the microscope. It is the result of a long-experienced want of some method of crystallizing the various oils and their acids so as to obtain micro-photographic views of their respective crystalline arrangement, a knowledge of which is important in microscopic investigations relating to the adulterations of foods and other oils. Another advantage offered by this invention is, that by this method objects in natural history mounted in varnish or other media may be thrown on a screen and photographed. In the use of sunlight or Drummond light, the liquid soon reaches 212° F., and thus renders useless a valuable mount.

EXPLANATION OF PLATES.

PLATE VIII.—THE TAYLOR FREEZING CELL.

In this plate *A* represents a microscope; *B*, the freezing-box, made of brass or of German silver and attached to the substage of the microscope by means of two clamps, one on either side of the box. *B* is a separate view of the apparatus; *a* and a^1 represent tubes, one of which supplies a freezing liquid, the other carries it off; a pail to receive the waste liquid is in readiness, and is connected in the usual way by means of rubber tubing; *c*, an opening through the center of the box, which admits of the transmission of rays of light to the object under investigation.

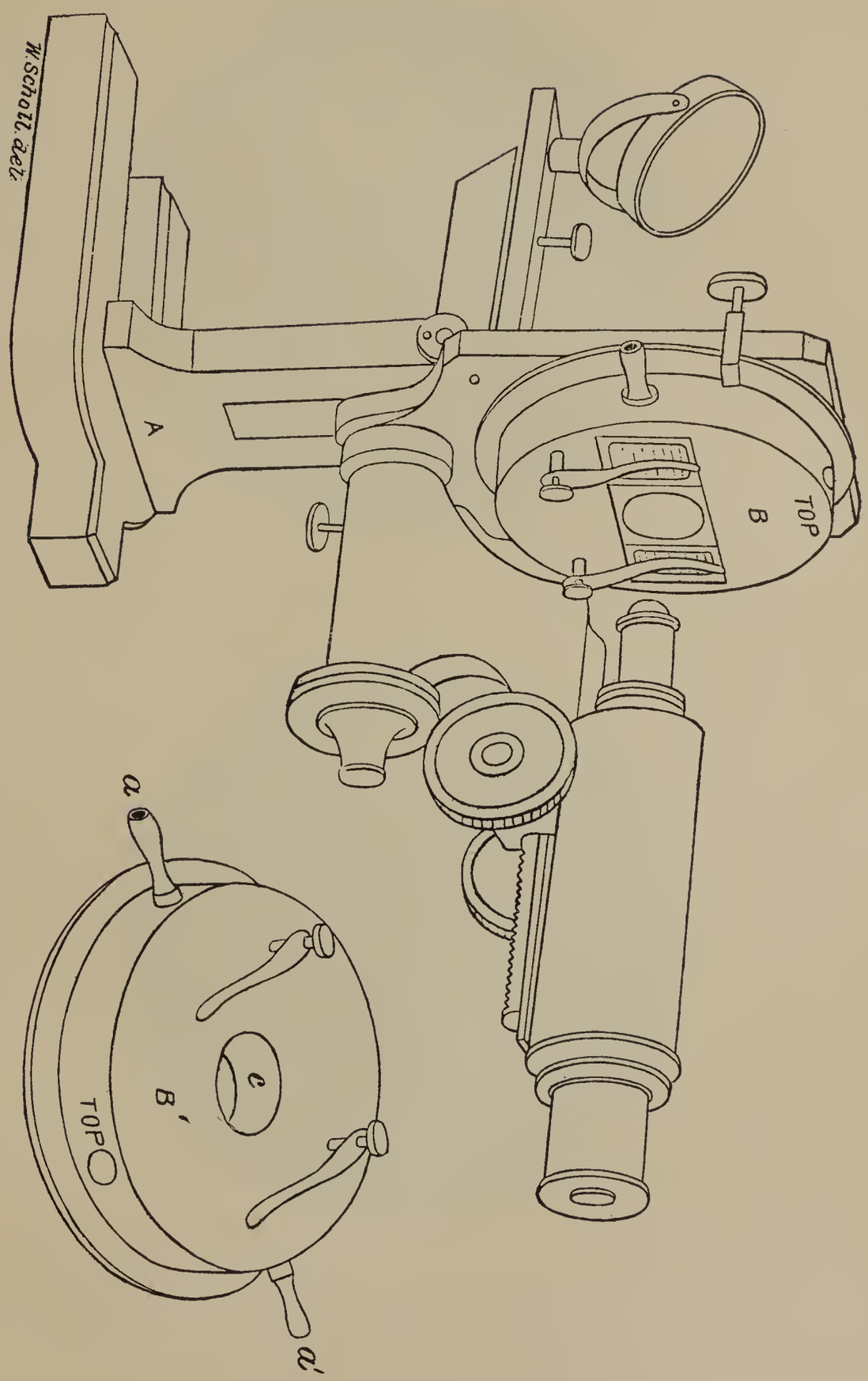
PLATE IX.—CHAULMUGRA FAT CRYSTALS.

This plate (Figs. 1 and 2) represents the crystalline forms of the solid natural fat of the oil of chaulmugra procured by the freezing process. The very peculiar forms which this fat assumes in crystallizing leads me to the belief that it is a new and undescribed fat.

The freezing liquid may be used repeatedly or until it ceases to be cold enough for the purpose. Any of the usual freezing liquids, or ammonia gas or ether may be used. The tube which carries off the liquid from the freezing-box should terminate in a small orifice to prevent unnecessary waste.

The box is provided with an air escape to facilitate the operation of filling the box with the freezing liquid. When this is accomplished, plug the opening and secure the box in position. In using ether, remove the plug to allow the ether to escape, or insert a tube to convey it into a separate vessel, where it may be condensed.

The solid fat of the chaulmugra oil is easily separated from the oil by freezing. The fat thus procured may be mounted in the usual manner. It should then be heated sufficiently to make it liquid and placed quickly under the microscope. As it cools, crystallization rapidly progresses. At first globular masses will be observed, each one showing, under polarized light, a well-defined cross. No sooner does one of these globular masses form than a second crystallization takes place, proceeding from the globular accretion in the form of an elongated, spreading fan. (See the micro-photographic illustrations, Plate IX, Figs. 1 and 2.)



ILLUSTRATING THE TAYLOR FREEZING CELL, A DEVICE FOR THE MICROSCOPE.

FIG. 1

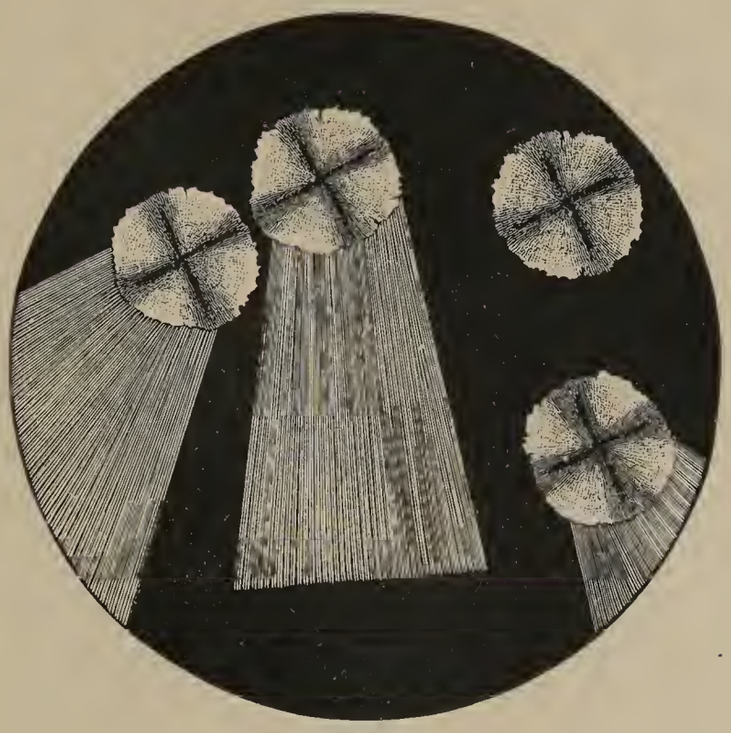
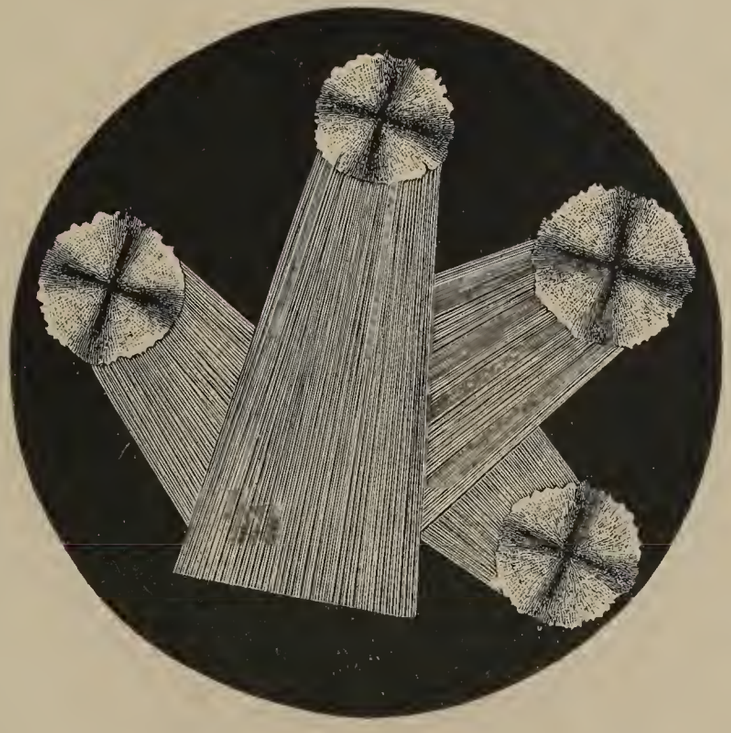


FIG. 2



CHAULMUGRA FAT CRYSTALS.